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IMPROVING THE EFFICIENCY
OF FORWARD PRESENCE
BY AIRCRAFT CARRIERS

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PREFACE

Aircraft carriers are the centerpiece of the U.S. Navy. The Department of Defense indicates that it needs 12 carriers in the fleet to provide forward presence in the Mediterranean, Pacific, and Indian Ocean theaters most of the time. Yet, on average, a carrier spends less than a quarter of its service life on-station in those theaters. This Congressional Budget Office (CBO) paper, prepared at the request of the House Committee on the Budget, examines several options to improve the amount of time a carrier spends in its theater. The options range from altering the ships' deployment cycle to creating an overseas home port for a carrier in the Mediterranean.

CBO was aided in its analysis by information provided by the Navy, the Department of Defense, the Center for Naval Analyses, and various independent analysts. In keeping with the Congressional Budget Office's mandate to provide objective analysis, this paper makes no recommendations.

Ivan Eland of CBO's National Security Division wrote the paper under the general supervision of Cindy Williams and R. William Thomas. Raymond J. Hall, Amy Plapp, and Jeannette Van Winkle of CBO's Budget Analysis Division estimated the costs for the options. William P. Myers, formerly with the Budget Analysis Division, estimated the costs for an earlier version of the analysis. Wayne Glass ensured that the paper was factually correct.

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SUMMARY

The modern U.S. Navy has been built around the aircraft carrier. That ship, with its battle group of surface ships and submarines and its resupply vessels, has been the major tool for projecting power ashore and controlling the seas during wartime. In peacetime, the carrier battle group has been used to remind national leaders of U.S. power through its presence in areas of tension. Such presence, according to its proponents, has deterred aggression, reassured allies, and allowed a more rapid response to regional crises than if carriers had sailed from the United States.

The average aircraft carrier, however, spends less than a quarter of its life providing presence--that is, being "on-station"--in overseas theaters. The main constraint on getting more presence out of each carrier is that the Navy limits the amount of time sailors spend at sea. In an environment in which demands for overseas presence are high and financial constraints are great, the Navy may want to get more out of the forces it is paying for. The Congressional Budget Office (CBO) examined several alternatives to improve the efficiency of carrier operations. They range from altering carrier deployment cycles to establishing an overseas home port for a carrier on the Mediterranean Sea.

In the past, the Navy justified the number of carriers in its fleet by saying that a particular force level was necessary both to fight wars and to provide adequate overseas presence during peacetime. With the end of the Cold War, however, the Bottom-Up Review conducted by the Department of Defense in 1993 identified peacetime presence as the driving force behind its goal of a fleet of 12 carriers (11 active and one reserve).

Even so, the current 12-carrier force cannot provide continuous presence in all three major theaters--the western Pacific, the Mediterranean Sea, and the North Arabian Sea/Indian Ocean. That requirement was developed during the later years of the Cold War but has now been relaxed. Based on historical data on the deployment of carriers, 12 ships provide 100 percent presence in the western Pacific and 79 percent presence, or an average of nine and a half months a year, in the other two regions. (The Navy defines its carrier based at a home port in Japan as being on-station in the western Pacific theater 100 percent of the time.) The Navy requires 12 carriers to provide that level of presence because the average carrier spends only about 23 percent of its time on-station.

CARRIER DEPLOYMENT AND OPERATING CYCLES

Each carrier follows a deployment cycle, only a small part of which is spent on-station. When not on-station, the ship is in one of three other phases: in transit to or from the operating area (which, together with the time spent on-station, makes up the period of deployment); in its home port for maintenance, crew rest, and shore training; or at sea for short periods of crew training or operations when not deployed (known as the nondeployed operations tempo, or "optempo," period). Those phases constitute the deployment cycle. Both conventionally powered and nuclear-powered carriers undergo several deployment cycles within one operating cycle, which is the time between complex overhauls (periods of major maintenance).

Because nuclear-powered carriers undergoing a complex overhaul cannot readily deploy in times of crisis, the Navy plans to change the operating cycle of those ships beginning next year. The Navy's new "incremental maintenance" plan will eliminate the period of complex overhaul and spread its extensive maintenance more evenly among the deployment cycles. Those longer periods of shorter-term maintenance will lengthen the deployment cycle for nuclear-powered carriers from the notional 21 months that the Navy uses for planning to 24 months.

In the new 24-month cycle, six months will be spent on deployment, 14 months in home port (including six months of short-term maintenance), and four months for nondeployed optempo. Under the new plan, the force of 11 active carriers and one reserve carrier could provide presence 100 percent of the time in the western Pacific and 84 percent of the time in the Mediterranean and the North Arabian Sea/Indian Ocean regions.

That amount of presence is greater than has actually been achieved under the current deployment cycle because it does not assume the additional maintenance that nuclear carriers have actually required. If past maintenance trends continue under the new plan, the Navy may not achieve a presence of 84 percent in the two regions.

OPTIONS TO IMPROVE THE EFFICIENCY OF FORWARD PRESENCE BY CARRIERS

CBO examined a number of alternatives to improve the efficiency of forward presence by carriers--allowing the Navy to either increase presence with its planned carrier force or achieve the same presence while reducing the number of carriers. Most of the alternatives have been proposed in some form by Navy personnel or by studies done for the Navy or the Congress. They range from altering the deployment cycle to establishing an overseas home port on the Mediterranean Sea.

Shorten the Deployment Cycle from 24 Months to 18 Months

This alternative would shrink the length of the deployment cycle from 24 months under the incremental maintenance plan to 18 months. The 18-month cycle would include six months for deployment, three months for nondeployed optempo, and nine months in home port for maintenance (six months), crew rest, and training ashore. Cutting the deployment cycle to 18 months might seem drastic, but in the early 1980s the Navy operated with cycles of just 16 months.

Under this alternative, the Navy could achieve the baseline presence of the incremental maintenance plan (100 percent presence in the Pacific and 84 percent in the other two theaters) with only nine carriers and eight air wings instead of 12 carriers and 11 air wings. A permanent reduction to that force level would save a net $2.1 billion a year, on average, in procurement and operation and support (O&S) costs.

Alternatively, if the Navy retained 12 carriers, shortening the deployment cycle would allow it to maintain 100 percent presence in the Pacific and 112 percent in the Mediterranean and the North Arabian Sea/Indian Ocean. That is, two carriers could be on-station in each of those two theaters some portion of the time.

Lengthen the Deployment Period from Six Months to Eight Months

Lengthening the deployment period from six months to eight months would boost the time spent on-station for every transit a carrier made to its operating area. That extra time would come at the expense of the time the crew would normally spend in its home port.

This option would allow the Navy to provide nearly its baseline presence with only eight carriers and seven air wings. Reducing the force to that level would save a net $3.1 billion in average annual procurement and O&S costs. Alternatively, increasing the period of deployment and keeping 12 carriers in the force would allow the Navy to maintain a presence of 100 percent in the Pacific and 125 percent in the other two regions.

Shuttle Multiple Crews to Carriers On-Station

Another way the Navy could improve the efficiency of carrier deployments would be to rotate crews and air wings to carriers that were on-station. The Navy's limit on the amount of time personnel are allowed to spend at sea is the major constraint to

the efficiency of carrier operations. The current personnel tempo ("perstempo") requirement states that crews must spend 50 percent of their time in their home port. By rotating crews and air wings, one set of personnel could be deployed while others were in home port or getting ready for a deployment.

Shuttling crews in that way would allow the Navy to maintain its baseline presence with fewer than eight carriers and nine crews and air wings, saving an average of at least $1.3 billion a year in procurement and O&S costs. Or the Navy could substantially increase presence by retaining the 12 carriers and shuttling crews and air wings to them on-station.

Transfer Two Carriers from the Pacific to the Atlantic

Basing more carriers on the Atlantic coast would bring a small gain in efficiency. The Navy deploys carriers on both U.S. coasts to the North Arabian Sea/Indian Ocean region. But the distance to that region from the Atlantic coast (using the Suez Canal) is about 3,500 nautical miles shorter than from the Pacific coast. If the Navy transferred two carriers from the West Coast to the East Coast, 11 active carriers could provide the baseline presence normally provided by 11 active carriers and one reserve carrier.

CBO estimates that eliminating the reserve carrier and the reserve air wing would save $1 billion a year in procurement and O&S costs. However, those savings would be partially offset by a one-time cost of about $200 million for moving the ships and creating any new facilities needed to accommodate them. Alternatively, transferring two carriers and keeping the existing carrier force would allow the Navy to keep a presence in both the Mediterranean and North Arabian Sea/Indian Ocean 87 percent of the time, rather than the 84 percent in the baseline.

Establish a Home Port on the Mediterranean Sea

If the Navy established a home port in the Mediterranean and considered the carrier deployed there as on-station 100 percent of the time--as it does with the one based in Japan--it could reduce the carrier force to eight ships and seven air wings. The one-time cost of constructing or upgrading the facilities needed at a home port ($700 million to $1.9 billion) is estimated to be substantially less than one year's average net savings from reducing the carrier force by four carriers and four air wings. Those savings are estimated to be $4 billion a year.

If the Navy chose to establish another home port and keep 12 carriers, it could provide 100 percent presence in the Pacific and Mediterranean theaters and 129 percent in the North Arabian Sea/Indian Ocean.

CHAPTER I

PATTERNS OF AIRCRAFT CARRIER DEPLOYMENTS

The aircraft carrier is the centerpiece of the U.S. Navy. Deployed in a battle group with its escort of surface ships, submarines, and resupply ships, it is both a weapon that can be used in wartime and a symbol of U.S. military presence in peacetime. In the past, the Department of Defense (DoD) determined the number of aircraft carriers that it needed based on both the number required for war and the number needed to provide sufficient peacetime presence overseas. During the Reagan Administration and early in the Bush Administration, the Navy maintained that it needed 15 carriers to fill either of those roles.

During the Clinton Administration, however, DoD's Bottom-Up Review (BUR) concluded that the peacetime presence mission determined the minimum number of carriers needed. The review said up to 10 carriers would be necessary to fight two major regional conflicts that occurred nearly simultaneously (four to five ships per theater). But it called for a 12-carrier force as the minimum needed to provide adequate peacetime presence in three key theaters--the Mediterranean, the western Pacific, and the North Arabian Sea/Indian Ocean.[1] Advocates of overseas peacetime presence say carrier battle groups deter regional aggressors, reassure U.S. allies, and allow a more rapid response to regional crises than if carriers had to sail from the United States.

Even so, given the Navy's current practices in deploying aircraft carriers, the force of 12 does not provide continuous presence in the three principal theaters of concern--a goal that was enunciated in the latter stages of the Cold War.[2] Earlier in the Cold War, the United States deployed its carriers primarily in the Mediterranean and western Pacific. After the Cold War, the requirement for a continuous presence in three theaters was relaxed somewhat.

The Congressional Budget Office (CBO) calculates that, based on recent deployment patterns, 15 carriers would be needed to provide continuous presence in all three theaters. (See the appendix for more details about this calculation, which uses a formula derived from Navy equations.) That figure implies that the Navy would need a total of five carriers in the force (15 carriers divided by three theaters)

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1. The BUR's 12-carrier force would contain 11 active carriers and one in reserve that could also be used for training.

2. Andrew Krepinevich, *The Bottom-Up Review: An Assessment* (Washington, D.C.: Defense Budget Project, February 1994), p. 33.

for every one it deployed to maintain such a presence. In the late 1980s, by contrast, the Navy stated that it needed three carriers in the force for every one it deployed. In the early 1980s, the Navy kept five carriers deployed out of a force of 13 at any one time--a 2.6-to-1 ratio.

According to the formula, the 12-carrier force can maintain year-round presence in one theater and provide presence 79 percent of the time (nine and a half months) in the other two theaters. Twelve carriers are required to provide that level of presence because the average aircraft carrier is "on-station" (patrolling its assigned theater) only 22.7 percent of the time. What does it do the other 77.3 percent of the time?

THE CARRIER DEPLOYMENT CYCLE

Each carrier has a deployment cycle, only part of which is spent on-station. When it is not on-station, the ship is in one of the following phases:

- In transit to or from its operating area (that time plus the time spent on-station equals the period deployed);
- In its home port for maintenance, and for leave and shore training for the crew; or
- At sea for short periods of crew training or operations when not yet deployed (called nondeployed operations tempo or "optempo").

For planning purposes, the Navy has used various lengths for the deployment cycle--18, 20, 21, and 22.5 months, according to Navy officials and documents. The 21-month cycle has been used most often. In reality, however, the average duration of the deployment cycle for nuclear-powered carriers has been 24 months since the beginning of fiscal year 1986 (when the current carrier deployment policy began). The average cycle for conventionally powered carriers has been 19 months. For both types of carriers, however, the length of the cycle and the activities within it vary from one deployment to the next.

Conventionally Powered Carriers

Conventionally powered carriers have a shorter deployment cycle because they need less time for maintenance than nuclear-powered carriers do. From that perspective, they are more efficient in providing overseas presence. In other words, they can

provide the same amount of presence with fewer ships or greater presence with the same number. In a typical 19-month cycle, after a conventionally powered carrier finishes a deployment, it spends 10 months in home port for maintenance, shore leave, and crew training (see Figure 1). That cycle meets the Navy's requirement that ships spend at least 50 percent of their time in home port over a period of five years for the sake of the crew's quality of life.

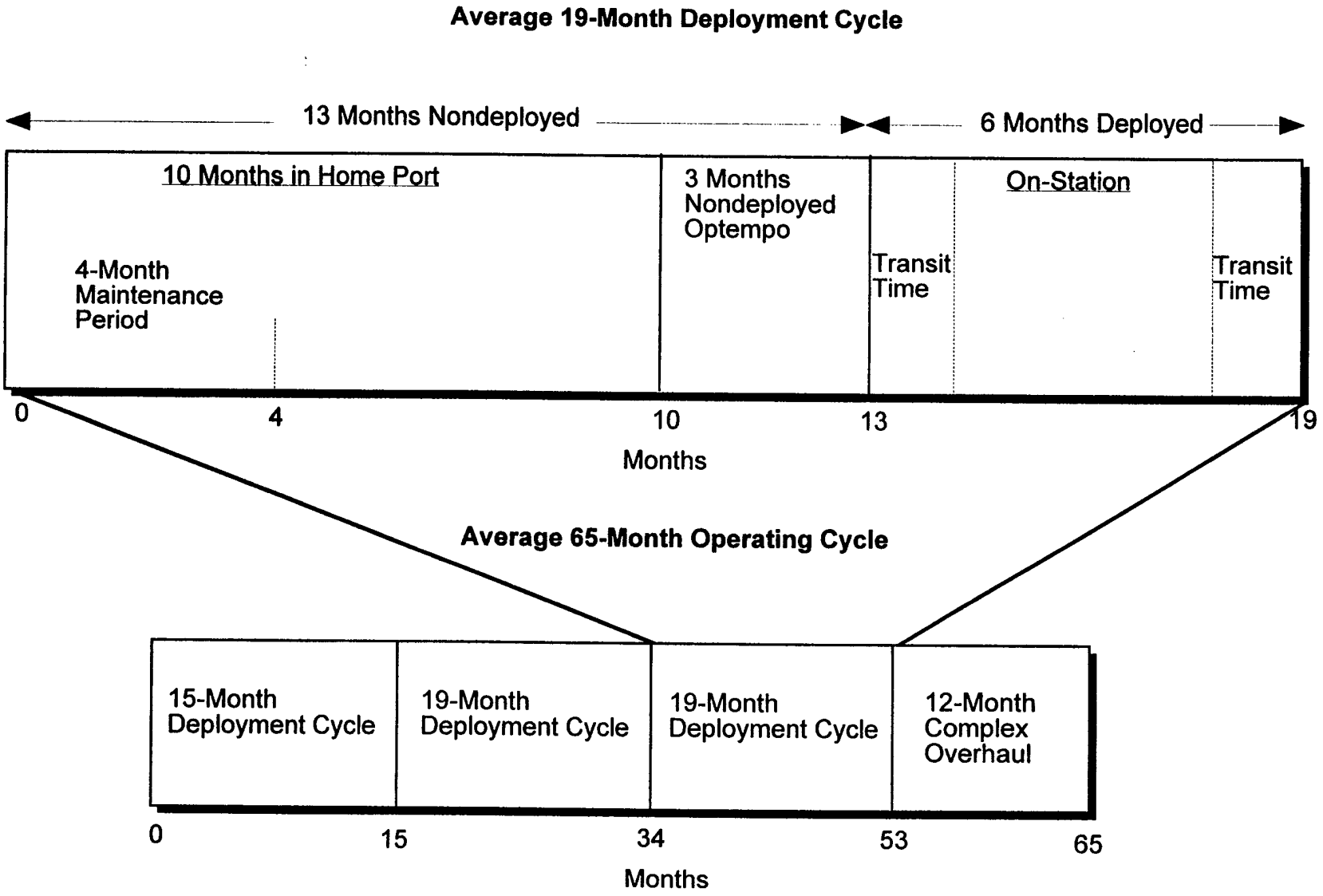
The Navy initiated that limit on the time at sea for a ship and its personnel (known as personnel tempo or "perstempo") in fiscal year 1986 because it believed that sailors were leaving the Navy at unacceptably high rates to avoid too much time at sea. The 50 percent perstempo restriction is an important constraint on the efficiency of carrier deployments. Additional Navy perstempo requirements include a minimum turnaround ratio--the ratio of nondeployed time to deployed time--of 2 to 1 and a maximum deployment period of six months.

Besides spending the 10 months in home port between six-month deployment periods, conventionally powered carriers engage in three months of activities that are counted as time at sea. That "nondeployed optempo" period consists of short, at-sea training cruises and exercises that allow the crew and air wing to hone their skills ("work up") before the next deployment. The period also includes nondeployed operations such as port visits in nearby countries, exercises with the navies of neighboring countries, or use of the ship to research, develop, and test new technology. When a crew is working up for a deployment, the work-up progresses from training individuals in their jobs to training members of a unit (such as the aircraft in the carrier's air wing) to operate together. Next, the ship trains with its air wing and later with other ships in the battle group and the forces of other services.

Once a carrier is deployed, it must spend part of its time in transit to and from its area of operations. Total transit time can consume anything from one month to more than two and a half months of the six-month deployment period, depending on the location of the home port and the area of operations. Transit to and from the North Arabian Sea or Indian Ocean, for example, requires much longer periods than transit to and from the Mediterranean.

The deployment cycle of an aircraft carrier is part of a larger operating cycle--the time between major maintenance periods. A conventionally powered carrier typically undertakes three deployment cycles before requiring a complex overhaul (see Figure 1). That overhaul generally lasts 12 months, during which the ship is taken apart and undergoes extensive maintenance and modernization. Thus, the

FIGURE 1. DEPLOYMENT AND OPERATING CYCLES FOR A CONVENTIONALLY POWERED CARRIER



complete operating cycle for a conventionally powered carrier lasts about five and a half years.[3]

Nuclear-Powered Carriers

Nuclear-powered carriers have different deployment and operating cycles because they require more maintenance than conventionally powered vessels do. During every deployment cycle they spend 14 months in home port, six months of which are for maintenance (rather than 10 months in home port with four months of maintenance). The complex overhaul for nuclear-powered carriers, which is conducted at the end of every fourth deployment cycle, usually requires 20 months instead of 12 months (see Figure 2). Also, Nimitz class nuclear carriers (all but one of the nuclear carriers in the force) are scheduled for a 32-month refueling complex overhaul near the middle of their service life--to undergo extensive maintenance and refuel the reactor--that conventionally powered carriers do not have. (The average 24-month deployment cycle of nuclear carriers is less efficient than the notional 21-month cycle that the Navy uses for planning. That 21-month cycle includes the same six months deployed but only 11 months in home port, of which three months are spent in maintenance.)

The operating cycle of nuclear-powered carriers lasts nearly 10 years rather than five and a half. On average, under current deployment cycles, a nuclear-powered carrier will spend 21 percent of its 45-year service life deployed, whereas a conventionally powered carrier will spend 28 percent of its life deployed.

According to the Navy, the lower efficiency and the higher procurement and overhaul costs of nuclear-powered carriers are offset by their increased combat power and greater endurance at maximum speed. Because such carriers do not have to burn and store large amounts of fossil fuel, they can store more ordnance and jet fuel for their aircraft and, at least in theory, go longer between replenishments.

Critics, however, contend that when the Navy actually deploys ships, it treats nuclear- and conventionally powered carriers the same. Also, they say, the Navy must replenish battle groups containing each kind of ship about equally often because most of the surface ships that escort and protect both types of carriers are

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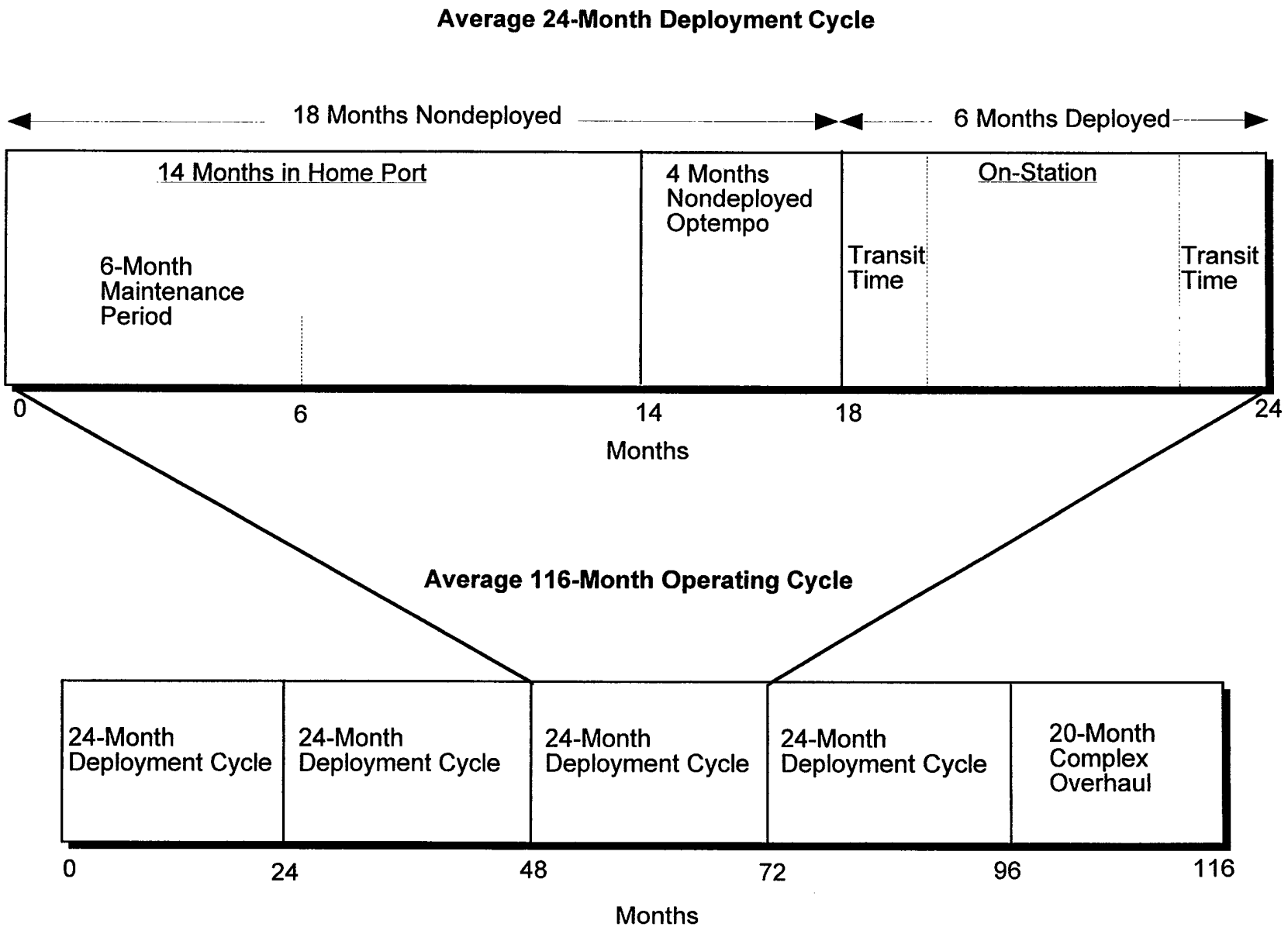
3. Although the average deployment cycle for a conventionally powered carrier is 19 months, Figure 1 shows that the first deployment cycle in the operating cycle is only 15 months. The four-month maintenance period is not needed then because the ship has just finished a complex overhaul in the previous operating cycle. For a nuclear-powered carrier, the first maintenance period (six months) is not eliminated but is spread throughout the operating cycle. Figure 2 has been simplified, however, to reflect the average 24-month deployment cycle during the operating cycle.

FIGURE 2. DEPLOYMENT AND OPERATING CYCLES FOR A NUCLEAR-POWERED CARRIER



conventionally powered.[4] Navy officials familiar with carrier operations acknowledge that the battle groups of both nuclear-powered and conventionally powered carriers regularly keep fuel stores replenished near capacity to hedge against the need to make a sudden, lengthy response to a crisis. In addition, critics claim that nuclear-powered carriers are constrained in their operations because they are restricted from visiting certain ports and from steaming through certain bodies of water. For example, they have not always been able to transit the strategic Suez Canal.

Despite that debate, the Navy continues to build nuclear carriers--at a cost of about $5 billion apiece in 1997 dollars. Once the carriers authorized by the Congress to date are finished--around 2003--the Navy expects to have a force of 10 nuclear-powered carriers and two conventionally powered ones, compared with a force of eight nuclear-powered and four conventionally powered carriers at the end of 1996. Thus, the nuclear carrier will soon dominate in planning both for wartime and for peacetime presence. According to its long-range plan, the Navy will request an 11th nuclear carrier in 2002, but the ship will not join the force until the end of that decade. Beyond that, the Navy is studying whether future carriers should be nuclear- or conventionally powered.

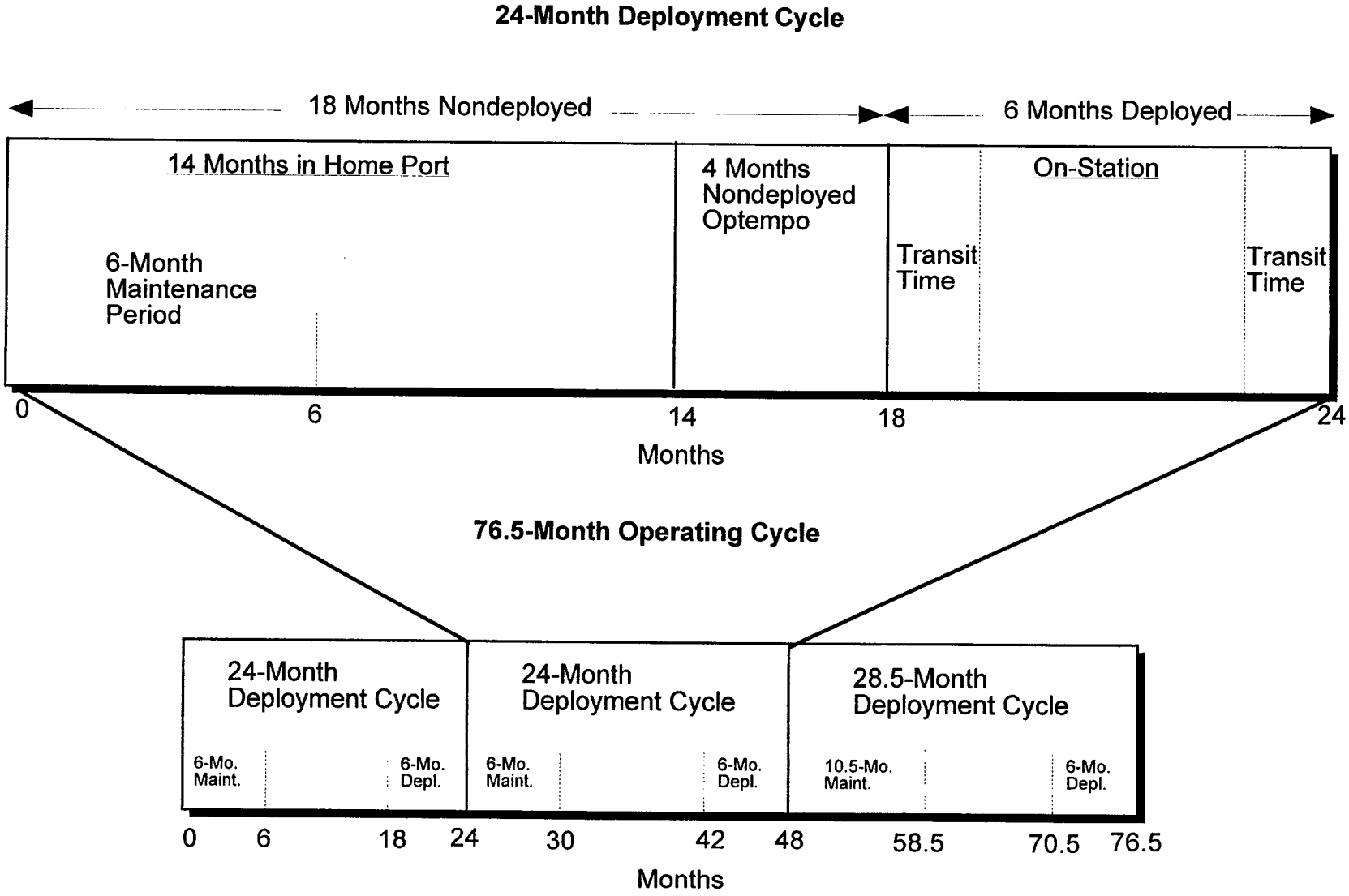
CURRENT PLANS TO CHANGE THE OPERATING CYCLE FOR NUCLEAR-POWERED CARRIERS

The Navy plans to alter the operating cycle for nuclear-powered carriers beginning next year. A nuclear-powered carrier that is in the middle of a complex overhaul cannot be deployed quickly in the event of a crisis. To allow such ships to be more available for use during crises, the Navy is eliminating the complex overhaul period and is spreading upkeep more evenly throughout the operating cycle by extending the shorter maintenance periods. Under this new "incremental maintenance" plan, the maintenance periods will be extended from three months (in the Navy's notional deployment cycle of 21 months) to six months, and a 10.5-month maintenance period in every third deployment cycle will replace the complex overhaul (see Figure 3). Also under this plan, the operating cycle will drop from 116 months to 76.5 months and include only three deployment cycles rather than four.

While undergoing these more frequent periods of less intensive maintenance, the carrier can be readied for a sudden deployment more quickly and the crew can remain in a higher state of readiness than during an extended period of overhaul. In fact, if the Navy can maintain nuclear-powered carriers according to the schedules

4. Hans Kristensen, William Arkin, and Joshua Handler, *Aircraft Carriers: The Limits of Nuclear Power*, Neptune Paper No. 7 (Washington, D.C.: Greenpeace, June 1994), pp. 3-5.

FIGURE 3. CHANGES IN DEPLOYMENT AND OPERATING CYCLES FOR NUCLEAR-POWERED CARRIERS BEGINNING IN 1997 UNDER THE INCREMENTAL MAINTENANCE PLAN



under the incremental maintenance plan, the carriers' average availability for crisis response will increase from 83.2 percent of their service life to 84.5 percent. (The historical availability for conventionally powered carriers is 82.2 percent.)

With the shorter maintenance periods being extended by three months under the new regimen, deployment cycles within the operating cycle will officially increase from a notional 21 months to the 24 months they average now (see Figure 3). Under the new deployment cycle, a carrier will be at sea 42 percent of the time, still well below the 50 percent maximum allowed.

Because CBO's analysis requires a baseline with which to compare alternatives to improve the efficiency of carrier presence, CBO used as its base case the theoretical presence that the incremental maintenance plan would achieve by 2003. For the current force of 11 active carriers and one reserve, that presence would be a carrier in the Pacific 100 percent of the time and a carrier in both the Mediterranean and the North Arabian Sea/Indian Ocean regions 84 percent of the time.

The presence projected under the Navy's plan is greater than has been achieved under the current deployment cycle (100 percent in the western Pacific and 79 percent in the other two regions) because, in practice, nuclear carriers have required an average of three months' more maintenance per deployment cycle than anticipated. If that trend continues under the new plan, the Navy may not achieve a presence of 84 percent in the two regions. The absolute amount of presence used for CBO's baseline is not critical, however, because all of the alternatives that are compared with it will have to provide similar amounts of presence. Therefore, CBO used the theoretical 84 percent even though the Navy may not be able to achieve it in practice. Using that theoretical presence, the average carrier would be on-station 23.3 percent of the time, compared with 22.7 percent historically.

CHAPTER II

ALTERNATIVES TO IMPROVE THE EFFICIENCY OF CARRIERS

Several alternatives to increase the efficiency of aircraft carrier deployments have been proposed by Navy personnel or by studies done for the Navy or the Congress. Because the future carrier force will be mainly nuclear powered, most of the alternatives would largely affect nuclear carriers. (Around 2003, conventionally powered ships probably will be used only for the one carrier that the United States bases permanently in Japan and the one in reserve.) The proposals take two approaches: filling gaps left by the baseline presence of 12 carriers--thus giving 100 percent or better presence in all theaters--or reducing the number of carriers needed to provide the baseline presence.

All of the alternatives would allow the number of carriers and air wings to be cut and would thus save an average of $1 billion to $4 billion a year (see Table 1). Most of the alternatives would reduce the fleet to eight or nine carriers, within the eight-to-10 range that the Bottom-Up Review said would be needed to fight two regional conflicts that began nearly simultaneously.[1]

If the Navy retained 12 carriers, the alternatives examined here could increase overseas presence substantially (see Table 2). Increasing presence, however, would increase costs. For example, shuttling crews and air wings to carriers on-station in a theater in this situation would require that crews and air wings be added to the Navy's force structure.

The first two options would either increase the amount of time a carrier is deployed or shrink the amount of time between deployments. Either way, the amount of overseas presence provided by each carrier during its service life would rise.

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1. If a decision was made to reduce the number of carriers to nine or fewer, normally the oldest conventionally powered and nuclear-powered vessels would be retired early because they have less useful life left. Doing so would leave only the relatively modern Nimitz class nuclear carriers in the fleet. The Navy could then be faced with a problem if the Japanese public refused to allow the basing of a nuclear warship in its port. The alternative is to retain an older conventional carrier and instead retire a Nimitz class carrier, which is expensive and has more useful life left. The Navy will eventually face this problem anyway if it continues to buy nuclear carriers after the 11th Nimitz class vessel planned for purchase in 2002 and continues to base a carrier in Japan. For the long term, the Navy is still considering whether it should continue to buy nuclear carriers or revert to conventionally powered vessels.

TABLE 1. AVERAGE ANNUAL SAVINGS FROM FIVE ALTERNATIVES TO INCREASE THE EFFICIENCY OF CARRIER DEPLOYMENTS

Alternative	Ships Cut	Air Wings Cut	Net Annual Savings (In billions of 1997 dollars)
Shorten Deployment Cycle from 24 to 18 Months	3	3	2.1
Lengthen Deployment Period from Six to Eight Months	4	4	3.1
Shuttle Multiple Crews to Carriers On-Station	4 (and 3 crews)	2	1.3
Transfer Two Carriers from the Pacific to the Atlantic	1 reserve	1 reserve	1.0[a]
Establish a Home Port on the Mediterranean Sea	4	4	4.0[a]

SOURCE: Congressional Budget Office.

a. Does not include one-time costs to move the carriers and build any new facilities needed to accommodate them.

SHORTEN THE DEPLOYMENT CYCLE FROM 24 MONTHS TO 18 MONTHS

This alternative would shrink the deployment cycle from the 24-month period under the incremental maintenance plan to 18 months. In the past, the Navy has used an 18-month period as one of its notional planning cycles (though, as noted earlier, historical data show that average deployment cycles for conventional and nuclear carriers have been greater). The Navy's notional 18-month cycle allocates three months for work-up training at sea and other nondeployed operations, six months for deployment, and nine months in home port for maintenance, crew rest, and shore training to meet the 50 percent personnel tempo ceiling (see Figure 4). Barring a reduction in the deployment period below the standard six months, the 18-month deployment cycle is the shortest one possible that can satisfy another Navy perstempo requirement: that the ratio of nondeployed time to deployed time be at least 2 to 1. To meet the requirements of the new incremental maintenance plan, the 18-month notional planning cycle would have to be modified to include six months of maintenance when the ship was in home port rather than an average of three months.

FIGURE 4. DEPLOYMENT AND OPERATING CYCLES UNDER AN ALTERNATIVE THAT WOULD SHORTEN THE DEPLOYMENT CYCLE FROM 24 MONTHS TO 18 MONTHS

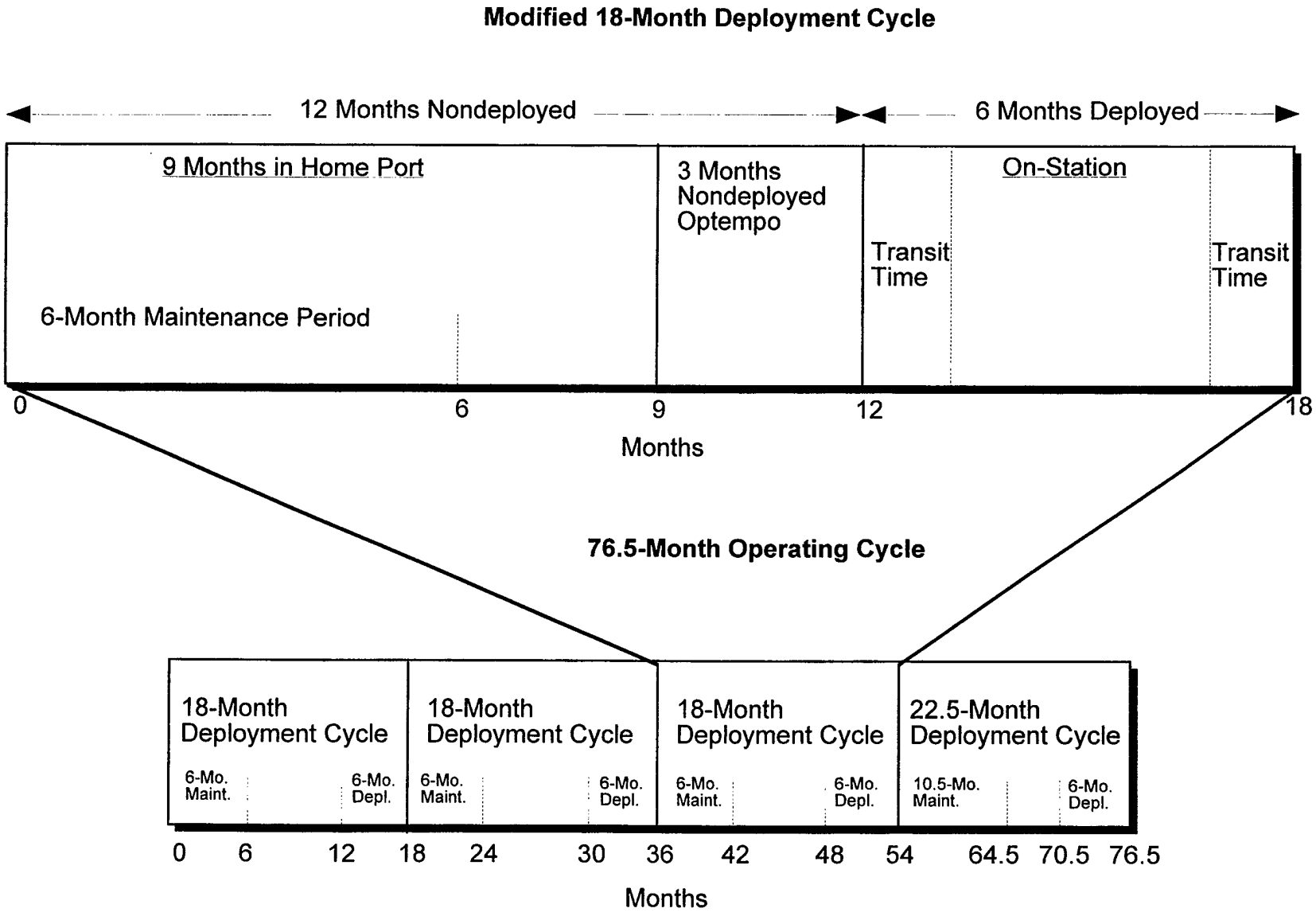

TABLE 2. OVERSEAS PRESENCE UNDER FIVE ALTERNATIVES IF FORCE LEVELS REMAIN THE SAME

Alternative	Percentage Presence in Two Theaters[a]
Shorten Deployment Cycle from 24 to 18 Months	112
Lengthen Deployment Period from Six to Eight Months	125
Shuttle Multiple Crews to Carriers On-Station	b
Transfer Two Carriers from the Pacific to the Atlantic	87
Establish a Home Port on the Mediterranean Sea	129[c]

SOURCE: Congressional Budget Office.

a. Assumes 100 percent presence in the Pacific.

b. Not directly comparable, but substantial added presence would result.

c. One hundred percent in the Pacific and Mediterranean and 129 percent in the North Arabian Sea/Indian Ocean.

Although cutting the deployment cycle to 18 months might seem drastic, in the early 1980s--before the Navy began enforcing its perstempo policies--the deployment cycle averaged 16 months. And a few years ago, a future executive officer of an F-14 aircraft squadron wrote an article analyzing plausible options that would cut the deployment cycle to as little as 15 months.[2] Furthermore, according to the author of a study that the Navy commissioned on carrier deployments, no more than 12 months are necessary for nondeployed activities--the maintenance and shore training in home port and the nondeployed optempo period.[3] If so, the Navy could reduce the nondeployment period from 18 months under a 24-month deployment cycle (see Figure 3) to 12 months under an 18-month deployment cycle (see Figure 4). One way to do that would be to cut nondeployed optempo from four months to three months and time spent in home port from 14 months to nine months.

2. See J.D. Oliver, "Use the Carriers or Lose Them," *Proceedings of the Naval Institute* (September 1993), pp. 68-69.

3. Conversation with William H. Sims of the Center for Naval Analyses, author of the July 1992 study *Budget-Driven Carrier Employment Options and Implications for Future Carrier Design.*

If the period for nondeployed optempo was indeed cut to three months, some nondeployed fleet operations (such as port visits or exercises) might have to be scaled back. Reducing those operations could slightly reduce the effectiveness of carriers as a tool of diplomacy, but the average work-up training period of three months could be preserved.

Alternatively, the Navy could compress the work-up period to preserve fleet operations. For example, according to one carrier aviator, work-up training could be cut by one month and the lost training could be made up during the first month of the carrier's deployment.[4] Of course, that change would decrease the ship's readiness, at least during the first month. The portion of the work-up training that would be completed after the ship was deployed is a month of advanced training and exercises that help the carrier integrate itself fully with its battle group and provide practice in operating with Army and Air Force units and the forces of allied nations. However, before that advanced training--during the intermediate training phase--the carrier is already certified to deploy if it is needed during a crisis. And a former Navy officer has argued that with the end of the Cold War, less training and fewer exercises are needed.[5]

Other Navy officials contend that making up lost training while on deployment might mean the training would not be completed if a crisis occurred early in the deployment. In addition, the officials say, training during work-up--unlike most training on deployment--allows the use of training ranges where live ordnance can be shot and success measured. Reducing the work-up period might become more attractive, however, if training by simulation could replace part of the work-up training at sea, as at least one naval analyst has suggested might be possible.[6]

The other aspect of reducing the nondeployment period--cutting the time in home port from 14 months to nine months--would probably affect the time spent for rest and shore training for the crew. As noted earlier, however, the modified 18-month cycle would still meet the perstempo requirement of 50 percent and the minimum turnaround ratio of 2 to 1.

If the Navy pursued this option and cut the deployment cycle from 24 months to 18 months, four cycles rather than three could fit into the 76.5-month operating

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4. Oliver, "Use the Carriers or Lose Them," pp. 67-68.

5. Christopher Preble, "Shrink, Shrink, Shrink the Navy," *USA Today Magazine* (May 1994), pp. 14-15.

6. Ronald O'Rourke, *Naval Forward Deployments and the Size of the Navy*, CRS Report for Congress 92-803F (Congressional Research Service, November 13, 1992), p. 5.

cycle under the incremental maintenance plan (see Figures 3 and 4). In that case, only nine carriers and eight air wings would be needed to provide the baseline amount of presence under the plan, instead of the 12 carriers and 11 air wings the BUR force requires when a 24-month deployment cycle is used.

Reducing the current force to nine active carriers and eight active air wings would save the Navy an average of $2.1 billion a year (see Table 1). That figure reflects about $3 billion in savings offset by $950 million in added costs. The Navy would save about $1.8 billion annually in operation and support (O&S) costs by retiring ships and air wings early: two conventionally powered carriers at about $400 million apiece per year, one nuclear-powered carrier at $300 million per year, two active air wings at $280 million apiece per year, and one reserve air wing at $150 million per year. The Navy would save another $1.2 billion a year in procurement costs by buying three fewer nuclear carriers and air wings. (The figure for average annual procurement savings comes from dividing the cost to buy three nuclear carriers and three air wings by the service lives of the ships and aircraft, respectively.) The $950 million in added costs under this alternative would result from operating the remaining ships and aircraft more intensively--that is, increased operation and support costs and increased procurement costs as systems wore out more quickly.

The $2.1 billion estimate of net savings and others in this paper are based on the Congressional Budget Office's estimate that one nuclear-powered carrier and its air wing cost about $400 million annually to procure (see Table 3). In the long term, if the Navy decided to again buy potentially less expensive, conventionally powered carriers--for which it has not estimated the cost--the savings for this alternative (and all subsequent ones) might be reduced somewhat when measured against that base case.

If the Navy decided to cut the deployment cycle to 18 months but retain 12 carriers, the increased efficiency of deployments would allow it to close the gaps left by the BUR force. The Navy could maintain a presence 100 percent of the time in the Pacific and 112 percent in the Mediterranean and North Arabian Sea/Indian Ocean. In other words, the latter two regions would sometimes have two carriers providing presence. Using carriers more intensively to increase presence, however, would result in a net cost increase from higher O&S costs and increased procurement costs to replace equipment that wore out faster than normal.

TABLE 3. AVERAGE ANNUAL COST OF A CARRIER AND ITS AIR WING (In millions of 1997 dollars)

	Procurement	Operation and Support
Conventionally Powered Carrier	a	400
Nuclear-Powered Carrier	120	300
Active Air Wing	280	280

SOURCE: Congressional Budget Office.

a. The Navy has not decided whether carriers purchased after 2002 will be nuclear- or conventionally powered. Thus, no estimate of the cost to procure a newly constructed conventionally powered carrier is publicly available.

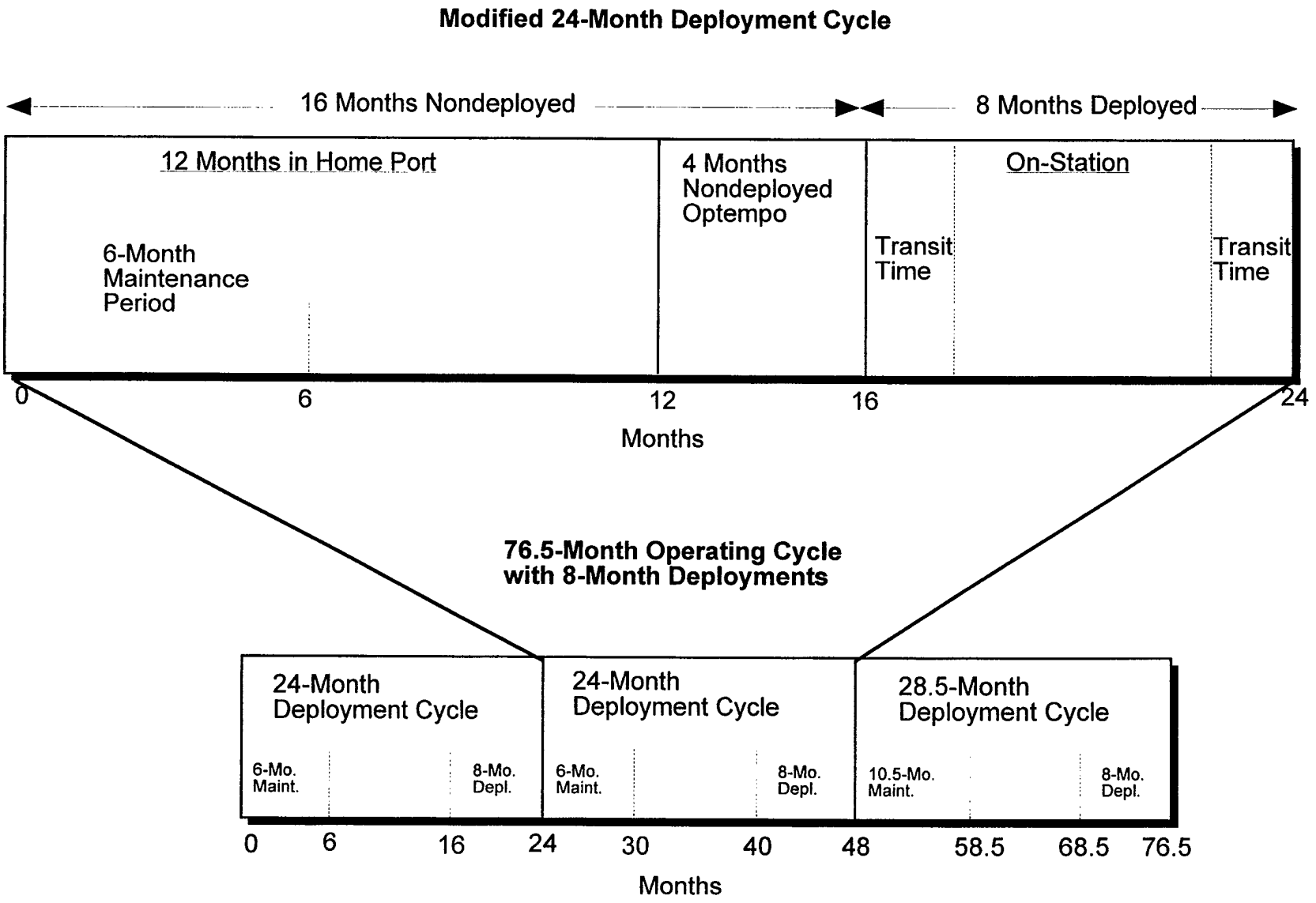
LENGTHEN THE DEPLOYMENT PERIOD FROM SIX MONTHS TO EIGHT MONTHS

Some naval analysts have studied lengthening the deployment period to eight months to increase the time on-station for every transit a carrier makes to its area of operations.[7] Instead of shrinking the entire deployment cycle by cutting the non-deployed portion of it, as in the previous alternative, the cycle could be held constant at 24 months and the deployment period extended from six to eight months (see Figure 5). The extra time spent deployed would come at the expense of time ashore for the crew but would still meet the perstempo requirement of 50 percent. Increasing the period of deployment to eight months would increase the amount of time deployed from 18 months per six-and-a-half-year (76.5-month) operational cycle to 24 months per cycle.

By increasing the amount of time each carrier was deployed, the Navy could maintain nearly the baseline amount of presence with just eight carriers and seven air wings. Cutting the fleet to that size would save an average of $3.2 billion a year: $2.4 billion in lower O&S costs from retiring early three active and one reserve carrier (two conventionally powered and two nuclear powered) and three active and one reserve air wing; $1.6 billion a year in lower procurement costs from buying four fewer nuclear-powered carriers and four fewer air wings in the future; and an off-

7. Timothy Cooke, Allan Marcus, and Aline Questor, *Personnel Tempo of Operations and Navy Enlisted Personnel* (Alexandria, Va.: Center for Naval Analyses, February 1993), pp. viii, ix, 45, and 46; and Oliver, "Use the Carriers or Lose Them," p. 67.

FIGURE 5. DEPLOYMENT AND OPERATING CYCLES UNDER AN ALTERNATIVE THAT WOULD LENGTHEN THE DEPLOYMENT PERIOD FROM SIX MONTHS TO EIGHT MONTHS



setting $800 million per year in added O&S and procurement costs for using the remaining carriers and air wings more intensively.

That savings of $3.2 billion a year does not include costs the Navy might need to incur to counteract the reduced retention associated with longer deployments. Unlike a decrease in turnaround time, an increase in the length of deployment from six to eight months would probably reduce the retention of sailors slightly. According to a study by the Center for Naval Analyses (CNA), such an increase in deployment length would decrease retention rates among enlisted personnel by 2 percentage points.[8] That is not the severe effect the Navy fears, but it might be one the Navy would want to counteract.

To offset the 2 percentage-point decline, according to the CNA study, the Navy would need to increase by an average of only one level its selective retention bonuses (SRBs)--monetary incentives paid to people who are eligible to reenlist to encourage them to do so. (To retain certain types of sailors, such as those with sea-intensive occupations, their SRBs might have to increase further.) That increase would have the approximate effect of raising the pay of all Navy enlisted personnel 5 percent above the rate of increase in the civilian sector. It would, however, be only 20 percent as expensive because the SRBs are paid to only 20 percent of the enlisted force. CBO estimates that raising SRBs by one level would cost $100 million per year.[9] Thus, the net annual savings from increasing deployments to eight months and reducing the number of carriers would average $3.1 billion per year if the Navy continued to purchase nuclear-powered carriers. As mentioned earlier, savings might be less if the Navy began buying potentially less expensive, conventionally powered carriers again and the savings were measured against that base case.

Alternatively, if the Navy chose to lengthen deployments but kept the same number of carriers, it could maintain a presence 100 percent of the time in the western Pacific and 125 percent in both the Mediterranean and the North Arabian Sea/Indian Ocean. (In other words, two carriers could be on-station in each of those two theaters a significant portion of the time.) Using the carriers more intensively,

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8. Cooke, Marcus, and Questor, *Personnel Tempo of Operations and Navy Enlisted Personnel*, pp. viii, ix, 45, and 46. This study, like others, shows that increased sea duty has a negative but small effect on reenlistment rates. (Also see Martha E. Shiells and Joyce S. McMahon, *Effects of Sea Duty and Advancement on First-Term Retention* (Alexandria, Va.: Center for Naval Analyses, June 1993); and John T. Warner and Matthew S. Goldberg, "The Influence of Non-Pecuniary Factors on Labor Supply: The Case of Navy Enlisted Personnel," *Review of Economics and Statistics* (February 1984), pp. 26-35.) Cooke, Marcus, and Questor may underestimate the changes in retention, however, because the Navy has had no experience with routine eight-month deployments since the late 1970s. Instead, eight-month deployments were sporadic during the period studied by CNA. Nevertheless, the study may provide the best estimate available of the effect of longer deployment periods on retention.

9. Navy officials dispute whether paying sailors more would completely offset the decrease in retention. They argue that other quality-of-life issues--such as time spent with families--also matter to sailors.

however, would result in a net cost increase because O&S costs would increase and procurement costs would rise to replace equipment that wore out faster than normal.

SHUTTLE MULTIPLE CREWS TO CARRIERS ON-STATION

The Navy also could boost efficiency by reducing the number of carriers and shuttling crews to those that remained.[10] Under the operating cycle in the incremental maintenance plan and all the alternatives examined so far, the main constraint on efficiency has been the perstempo requirements for the crew of the ship and the air wing rather than any limitations imposed by the carrier. By having more than one crew per carrier, the requirement that a crew spend 50 percent of its time in home port would no longer constrain the carrier because the ship could keep operating with different crews. The chief constraint to efficiency would then become how long the carrier could go between major maintenance periods.

Under both the current operating cycle and the incremental maintenance plan, a nuclear carrier will normally undergo major maintenance after 18 months of use. If 18 months between major maintenance periods is the limit to the ship's endurance, an alternative approach would involve letting carriers deploy for that long but rotating three crews during that period. Each of the crews would deploy for six months, and crews would serve on more than one ship (see Figure 6).

To achieve maximum efficiency, the carrier would sail to a port overseas at the end of one crew's deployment, and a new crew would be flown from the United States to relieve the one aboard. This concept differs somewhat from the dual crews that are assigned to each nuclear ballistic missile submarine (SSBN) because those vessels travel back to their home port for crew rotation ("swapping out"). One likely reason is that swapping out SSBN crews on-station would reveal the deployment patterns of those secretive ships. Swapping out crews on-station might be a viable option for carriers, however, because their deployment patterns are less closely guarded. Exchanging crews on-station also saves a great deal of transit time because a ship only has to return to its home port after three crew deployments rather than after each one. For that reason, the Navy has begun swapping out crews for some mine-countermeasures ships that are on-station.

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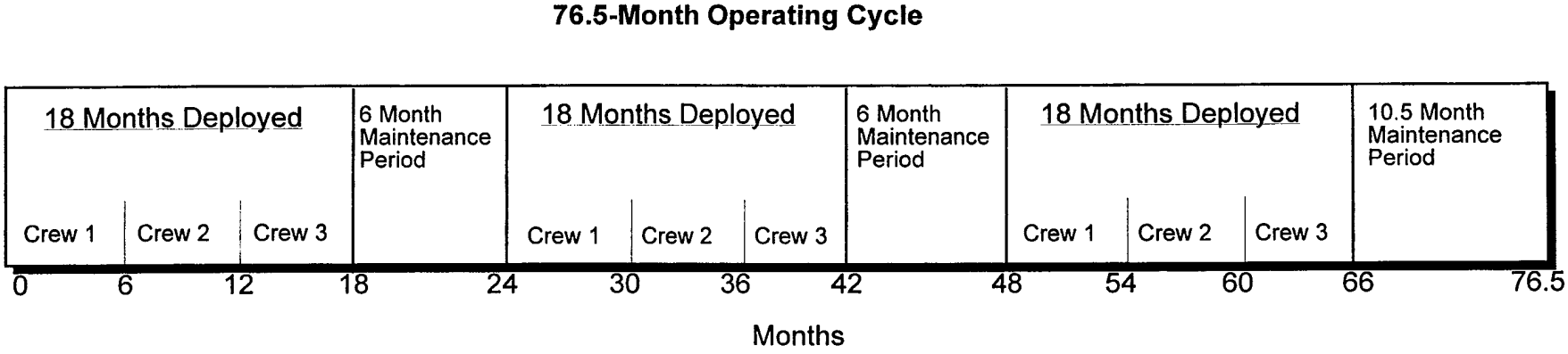
10. Oliver, "Use the Carriers or Lose Them," pp. 68-69, analyzes options for shuttling crews but uses 15-month and 16-month operating cycles for the carriers. CBO modified the option by using the less compressed 19-month operating cycle that conventionally powered carriers already use.

FIGURE 6. OPERATING CYCLE UNDER AN ALTERNATIVE THAT WOULD USE MULTIPLE CREWS WITH THE NAVY'S INCREMENTAL MAINTENANCE PLAN



Although carriers operate for 18 months between maintenance periods under the incremental maintenance plan, as noted earlier, they are not at sea for all of that time. An aircraft carrier that was at sea and deployed for 18 months might incur more wear and have fewer chances for short-term upkeep than one that spent some time in port during the 18-month period. Thus, the carrier might need a short maintenance period when the crew was exchanged or at some other port. In that case, the Navy might require maintenance facilities and temporary quarters for the crew in a selected foreign port in the ship's theater. (Those facilities would not have to be as extensive as the more comprehensive maintenance shops and permanent facilities for dependents that are necessary when establishing a home port overseas--the next alternative.) In lieu of shore facilities, tenders--floating maintenance shops that were recently retired--could be reactivated and deployed to overseas ports to handle such maintenance. Because the Navy counts a carrier in its theater of operations as on-station even when it is in port for maintenance or crew rest (for example, the carrier based in Japan is always regarded as being on-station, even when it is in port), short periods of maintenance while in the theater would not reduce the time on-station.

If crews were swapped out on-station, some carriers would need to be held in nondeployed status to allow crews to complete work-up training at sea before deploying to carriers already on-station. To even out the wear on all carriers in the fleet, those work-up carriers could be deployed every so often and the deployed ones rotated for use in work-up training. One disadvantage of shuttling crews to a carrier already on-station is that crews cannot do work-up training on the same ship on which they will be deployed. This option would apply only to Nimitz class (CVN-68) nuclear carriers, but some differences exist even among those ships and the aircraft on board.

Although the Navy swaps out crews of mine-countermeasures ships and SSBNs, Navy officials maintain that doing so on larger ships would involve much greater logistical effort. Nimitz class aircraft carriers have crews of about 6,000 people, in contrast to SSBNs, which have crews of about 160, and mine-countermeasures vessels, which carry crews of 50 to 80 people. In the case of carriers, officials argue, the Navy would probably have to find a large number of temporary quarters in a foreign port for the crews during the swap. However, to minimize any dislocations caused by such a large turnover of personnel, the Navy could stagger rotations so that only a portion of the crew swapped out at one time. And to see if shuttling crews to carriers was feasible, it might institute a pilot program on one ship to test the concept.

Another potential difficulty with shuttling crews is that reactor personnel, once they become qualified, are allowed to operate only a specific ship's reactors. Several changes are possible to overcome that problem:

- A reactor crew could qualify on the reactor of more than one ship.
- The reactor crew for each carrier could stay with the ship when the rest of the crew rotated. That might entail long deployments for reactor crews, but as noted above, the Navy could increase selective reenlistment bonuses to prevent those sailors from leaving the service.
- Each carrier could have multiple reactor crews.

Shuttling crews while on-station would allow the Navy to maintain the baseline presence in all three theaters with fewer than eight carriers--a maximum of five for deployments, two for work-up training, and one undergoing an overhaul to refuel its nuclear reactors--along with nine active crews and air wings. Adopting this option would yield $1.3 billion in annual net savings. The Navy could save $1.7 billion per year in O&S costs by cutting its carrier fleet by three active carriers and one reserve carrier (two nuclear-powered and two conventionally powered) from the current force of 12 (11 active and one reserve). It could also cut the number of crews from 12 to nine (all active) and the number of air wings from 11 (10 active plus one reserve) to nine (all active). It could save an additional $1 billion per year by forgoing procurement of four future nuclear-powered carriers and two air wings. Partially offsetting those savings would be about $1.4 billion a year in expenses, including $1.3 billion to operate the remaining carriers more intensively, about $50 million to transport crews rotating to and from the theater, and $75 million to operate and support two tenders operating from overseas ports (one each to service the carriers in the Mediterranean and North Arabian Sea/Indian Ocean theaters).[11] The annual net savings could be less than $1.3 billion if the Navy began buying conventionally powered carriers in the future and this alternative was compared with that potentially less expensive base case.

TRANSFER TWO CARRIERS FROM THE PACIFIC TO THE ATLANTIC

One option the Navy is studying for possible gains in efficiency is to base more of the carrier force on the Atlantic coast. Of the 12 carriers now in the fleet, six are based on the East Coast, five on the West Coast, and one in Japan. The home ports on the East Coast usually send carriers to the Mediterranean Sea and the North Arabian Sea/Indian Ocean regions. The home ports on the West Coast send carriers mainly to the latter area, and the carrier based in Japan normally patrols the western Pacific region.

11. There would also be a one-time cost of $50 million to reactivate the two retired tenders.

Although carriers from both coasts sail to the North Arabian Sea and Indian Ocean, the distance from the East Coast is shorter, provided the ship can travel through the Suez Canal and Red Sea. The distance from the East Coast to those theaters is about 8,200 nautical miles when the ship uses the waterway and 11,600 nautical miles when the ship is forced to go around the southern tip of Africa. The distance from the West Coast to the North Arabian Sea/Indian Ocean is 11,700 miles.

The Navy is studying whether to move some of the carrier force based on the West Coast to the East Coast. If two nuclear-powered carriers were transferred to the East Coast and allowed to use the Suez Canal and Red Sea, a small gain in overseas presence would result (87 percent presence in both the Mediterranean and North Arabian Sea/Indian Ocean rather than the baseline presence of 84 percent). Alternatively, only 11 active carriers would be needed to provide the baseline presence. Therefore, the Navy could eliminate the reserve carrier and the reserve air wing for total savings of nearly $1 billion a year: $550 million in reduced operation and support costs and $400 million from eliminating the need to procure one additional carrier and air wing in the future.

One-time costs of $200 million to transfer the two ships would partially offset those annual savings. The only port on the East Coast equipped to accommodate nuclear carriers (Norfolk, Virginia) has constraints on its capacity. Added facilities would be needed to accommodate the ships. The Navy would also incur costs to move the ships from one coast to the other and to close some facilities on the West Coast.

If two ships were transferred, the number of carriers quickly accessible to the Pacific region would be reduced at a time when that area is becoming more important economically to the United States. The fastest growing economies in the world are in East Asia, and U.S. trade with the Pacific Rim exceeds that with Western Europe. In addition, if a war started in the Korean Peninsula or elsewhere in the Pacific Rim, only a maximum of four carriers--the one in Japan and the three remaining in West Coast home ports--would be near the theater. That number is at the lower end of the four-to-five-ship range cited in the Department of Defense's Bottom-Up Review as needed to fight a major regional conflict. If carriers on the East Coast were needed to supplement those ships, they would have to steam around the southern tip of South America because they are too large to pass through the Panama Canal.

Finally, if the Suez Canal and Red Sea were closed to U.S. carriers based on the East Coast, the advantage of the shorter distance to the North Arabian Sea/Indian Ocean would be negated. In the early 1980s, terrorists mined the Red Sea. In addition, Egypt has often been reluctant to let nuclear-powered ships pass through

the Suez Canal. That policy may become a greater problem as the United States replaces older, conventionally powered carriers with nuclear-powered vessels.

ESTABLISH A HOME PORT ON THE MEDITERRANEAN SEA

Establishing a home port for a carrier in a Mediterranean country--perhaps Spain or Italy--might allow some of the U.S.-based carriers that provide presence in the Mediterranean to be eliminated from the force. That would yield greater annual savings than any of the other options considered in this paper.

Under the operating cycle in the incremental maintenance plan, the Navy would need about five carriers to keep one on-station continuously in the Mediterranean Sea. But it cannot do so now unless it reduces presence in another theater. If the Navy established a home port in the Mediterranean and counted a carrier deployed there as on-station at all times--as it does with the carrier in the Japanese home port--it could reduce its carrier force by four ships (three active and one reserve) and four air wings (three active and one reserve) to eight carriers and seven air wings. With two carriers in overseas home ports, the eight-carrier fleet would provide 100 percent presence in the western Pacific and the Mediterranean (by definition), as well as 82 percent in the North Arabian Sea/Indian Ocean region. That closely approaches the baseline presence of 100 percent and 84 percent, respectively. (If the Navy established a Mediterranean port and kept 12 carriers, it could provide 100 percent presence in the western Pacific and the Mediterranean and 129 percent presence in the North Arabian Sea/Indian Ocean, but a net cost increase would result because of the added costs to base a carrier overseas.)

Reducing the force to eight carriers and seven air wings would reap about $4 billion a year in average net savings. Annual savings in O&S costs from cutting four carriers (two conventionally powered and two nuclear-powered) and four air wings would be $2.4 billion. Eliminating the need to buy four future nuclear carriers and aircraft for four air wings would save an additional $1.6 billion. (In the long term, those savings might be lower if the Navy again began to buy potentially less expensive, conventionally powered carriers.) The added costs of operating and supporting a carrier battle group in an overseas home port rather than in the continental United States are minimal--$10 million to $20 million a year--so this option would still net annual savings of about $4 billion (see Table 4).

Of course, some of those savings would also be offset by the one-time expense of establishing the home port--for example, upgrading existing facilities or

TABLE 4. COSTS OF ESTABLISHING AND OPERATING AN OVERSEAS HOME PORT IN TWO MEDITERRANEAN COUNTRIES (In millions of 1997 dollars)

	Spain	Italy
One-Time Costs to Construct or Upgrade Facilities to Create the Home Port	700	1,900
Increase in Annual Operation and Support Costs to Base a Carrier Battle Group Overseas Rather Than in the United States	10	20

SOURCE: Congressional Budget Office based on data from the Department of Defense.

building new ones. Based on information obtained from the Department of Defense, CBO estimates that those costs would total $700 million to $1.9 billion.[12] But those one-time costs of creating a home port would be substantially lower than the savings realized each year by reducing the carrier force by four ships and four air wings.

Although establishing a home port in Spain or Italy would save the United States money, the proposal faces two major problems: getting either country to accept the permanent presence of a carrier and related facilities, and dealing with the potential political restrictions imposed by the host nation on the use of the carrier once the home port was constructed.

With the demise of the Soviet threat, Spain and Italy might be less willing to host a military facility that could be used by the United States for interventions that might run counter to their foreign policy interests. Because of environmental concerns and antinuclear sentiments, those nations might be particularly reluctant to host a carrier if it was nuclear-powered. Even with the carrier force being reduced to eight vessels under this option, the Navy could elect to retain two older, conventionally powered ones to make hosting a carrier in a Mediterranean nation and at the existing home port in Japan more palatable to the local populations. To retain them, however, the Navy would have to retire two newer, Nimitz class nuclear-powered carriers considerably before the end of their service life.

12. Unclassified portions of Department of Defense, *Naval Forward Presence Report* (August 18, 1994), p. D-2.

Even if these countries allowed the home port to be built, in the event of a crisis they might impose constraints on the use of the carrier based there.[13] In addition, Navy officials argue that if a host nation ever evicted the United States from the home port after the carrier fleet had been reduced and those ships scrapped, the fleet would be hard to reconstitute. The Navy could improve its ability to do so by putting the two conventionally powered carriers removed under this alternative in mothballs, but that would be infeasible for the two nuclear-powered ships taken from the fleet because their power plants cannot be maintained in a reduced operating mode.

Yet, in spite of those same constraints, the United States maintains a home port in Japan. It already has to be concerned with possible political restrictions by the host nation on the use of the carrier there and with reconstituting modern carriers to fill the vacuum in overseas presence if the ship is evicted. In the lower-threat environment of a post-Cold War world, political restrictions on a carrier based in the Mediterranean or reduced presence if it was evicted might be more acceptable.

DoD maintains that political restrictions by the host nation on the use of the carrier, when added to reliance on an overseas base, diminish the advantages that naval presence has over presence provided by the other services.[14] The department argues that one of the chief advantages of naval presence is that it allows the United States to act independently because the Navy is relatively free from relying on bases in other nations. In addition, DoD argues, few potential sites for overseas home ports have the training facilities, live-fire ranges, and maintenance depots to ensure adequate levels of readiness for personnel, training, and materiel.[15]

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13. Ronald O'Rourke, *Aircraft Carrier Forward Homeporting*, CRS Report for Congress 92-744F (Congressional Research Service, October 2, 1992), p. 1.

14. Unclassified portions of Department of Defense, *Naval Forward Presence Report*, p. C-6.

15. Ibid., p. C-4.

APPENDIX

CALCULATING THE NUMBER OF CARRIERS NEEDED FOR CONTINUOUS PRESENCE

Using a formula derived from Navy equations for forward presence, the Congressional Budget Office (CBO) estimated how many aircraft carriers are needed to maintain a continuous presence in two of the three major areas of deployment--the Mediterranean Sea and the North Arabian Sea/Indian Ocean. (The carrier in the western Pacific, which has its home port in Japan, is considered by the Navy to be on-station there 100 percent of the time.) The number of carriers needed in the force to keep one continuously on-station in a theater equals:

$$\frac{S}{D(L-T)}$$

where
S = the length of the carrier's service life,
D = the number of deployments per service life,
L = the length of deployment, and
T = the round-trip transit time.

To illustrate how the formula works, CBO calculated how many nuclear carriers are necessary to provide continuous presence in all three theaters under the operating cycle in the Navy's new incremental maintenance plan. (Because two conventionally powered carriers will still be in the fleet in CBO's base year of 2003, CBO adjusted this formula slightly in its analysis to include both conventionally powered and nuclear-powered carriers. The results differ only slightly from the simplified calculations here.)

The service life of a nuclear-powered carrier is about 45 years, or 546.5 months. During that time, CBO calculated, the ship would make 21 deployments of six months each. Round-trip transit time to the Mediterranean is about 29 days, or 0.95 months; a weighted average of the round-trip times to the North Arabian Sea/Indian Ocean theater by carriers from the West and East Coasts is 75 days, or 2.46 months (including 10 days for maintenance and port calls). In both theaters, the length of deployment minus the round-trip transit time equals on-station time for each deployment period. The equation's denominator indicates the total time a nuclear carrier spends on-station during its service life.

Thus, the number of carriers in the force needed to keep one continuously on-station in the Mediterranean Sea is:

$$\frac{546.5}{21(6-0.95)} = 5.15 \text{ carriers}$$

The number of carriers in the force needed to keep one continuously on-station in the North Arabian Sea/Indian Ocean region is:

$$\frac{546.5}{21(6-2.46)} = 7.35 \text{ carriers}$$

Therefore, including the carrier in the Japanese home port that deploys to the western Pacific, a minimum of 14 carriers would be needed to maintain a continuous presence in all three theaters (1 + 5.15 + 7.35 = 13.5).

Although 12.5 carriers are required to provide continuous presence in both the Mediterranean and the North Arabian Sea/Indian Ocean theaters, the Navy has only 10.5 available. That number results from subtracting the carrier in Japan from the force of 11 active carriers and one reserve carrier (counted as 11.5). Dividing 10.5 by 12.5 yields 84 percent, the theoretical baseline presence in the two theaters provided by the incremental maintenance plan.

Using the same formula and historical data on carrier deployments (rather than the incremental maintenance plan, which has not yet been implemented), CBO calculated that the Navy would need 15 carriers to provide continuous presence in all theaters. More ships are needed because historical deployment patterns have been less efficient than the new plan. Thus, using historical deployments, the current carrier force provides a baseline presence of only 79 percent in both the Mediterranean and North Arabian Sea/Indian Ocean.